NOTES, ABSTRACTS, AND REVIEWS.

RADIO WEATHER REPORTING ON THE GREAT LAKES.

Following closely upon the establishment of the Pacific coast radio weather-reporting program by the Forecast Division of the Weather Bureau,[1] comes the announcement that this service will be amplified for the benefit of marine and aviation interests on the Great Lakes beginning April 15, 1922. This development is significant because it completes the service to all marine interests in waters contiguous to the United States whether in the Atlantic, Gulf of Mexico, Pacific, or Great Lakes.

In a circular issued April 1, 1922, this new service is described in detail. Concerning the major bulletins, it is announced that twice daily (noon and 11.30 p. m., seventy-fifth meridian time) between April 15 and December 20, the Great Lakes Naval Radio Station will broadcast on 1,988 meters wave length a message consisting of (1) the surface-weather conditions as observed at the preceding 8 a. m. or 8 p. m. observations, together with aerological observations taken in the morning or afternoon of the date of distribution; (2) a synopsis of general conditions, wind and weather forecasts for the upper and lower Lakes, storm warnings for the Lakes, and flying-weather forecasts for aviation zones extending between western New York, northern Ohio, and Indiana and western Kansas, Nebraska, and the Dakotas. Local bulletins will be distributed at various times of day from the naval radio stations at Alpena, Mich.; Buffalo, N. Y.; Chicago, Ill.; Cleveland, Ohio.; and Duluth, Minn.

These local bulletins apply to the particular Lakes near which the stations are located and consist largely of forecasts and storm warnings. Ships may call upon any of these stations for weather reports, warnings, or forecasts.

Copies of an appropriate base map for the plotting of weather data may be obtained free of charge by vessel masters from any Weather Bureau station on the Great Lakes.

Nearly coincident with the announcement of this new service comes the statement that on and after the opening of navigation in the Great Lakes all forecasts and storm warnings will be issued from the Chicago office of the Weather Bureau, instead of the Washington office as heretofore. In addition to this change, the States of Indiana and Michigan will be included in the Chicago forecast district.—*C. L. M.*

THE ANTITRADES.

By W. VAN BEMMELEN.

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The long series of pilot balloon ascents made at and near Batavia (lat. 6° 11′ S., long. 106° 50′ E.) during the years 1909–17 has given a fair knowledge of the system of air currents over west Java up to great heights. The general outcome of this investigation has been communicated to the Royal Academy of Science of Amsterdam.[1] My endeavor to explain that system led to a controversy between Doctor Braak and myself and Professor van Everdingen.[2] After renewed consideration of the problem I have come to new results which I propose to set out provisionally here.

In the memoir presented to the Amsterdam academy is inserted a synoptical table containing the mean directions and velocities of the wind for each month and for height intervals of 1 kilometer up to a height of 24 kilometers. In it the principal air currents have been made conspicuous by letter coloring and framing. They are:

First, the west monsoon prevailing during the southern summer in the bottom layers up to 5–6 kilometers.

Above it, up to 10–13 kilometers, blow easterly winds with southern components, which I would call trade-like winds. In the winter season such winds blow in the bottom layers up to 3 kilometers.

Above these trade-like winds blow antitrade-like winds, i. e., easterly winds with a northern component. Their upper limit reaches to 18 kilometers from December until March; it goes down to 12 kilometers in June, and again rises to the maximum height of 21 kilometers in October. The velocities show two maxima: In February at a height of 15 kilometers (12 meters per second) and in August at 14 kilometers (22 meters per second); in April they are very weak. Not only is their velocity a maximum, but also the transport of air mass.

Over the antitrade-like current appear again currents of trade-like character; however, from March until September an eastward moving air mass is embedded in them, reaching heights of 24 kilometers in *maximo*.[3] Very high balloon flights in March and September revealed the existence of strong (30–40 meters per second) easterly winds up to 30 kilometers.

Considering these results, three principal questions arise: (1) Are the trade-like winds real trades? (2) Is the antitrade-like current a true deflux from the Equator toward the subtropics? (3) Whence do the great velocities of the high antitrade-like and upper trade-like winds originate?

The currents mostly possess a stationary character, and consequently their directions will be in close agreement with the trend of the isobars in their level. For Java the latter will be conditioned by the neighborhood of the Australian continent. As in the southern winter over Australia is settled a circular HIGH, we may expect over Java the trend of the isobars to be ENE.–WSW. and the gradient to be toward the Equator. However, by friction with the earth surface the air blows across the isobars and takes an ESE.–WNW. direction. This means real outflow to the Equator; thus the trade-like wind mentioned above is a trade.

In the southern summer over Australia lies a LOW, causing the west monsoon, but above this LOW the gradient is reversed and a HIGH prevails. This causes in the same manner as mentioned above a trade-like wind. The friction required for it, I presume, is caused by the streaming one over another of the two currents with contrary directions (the west-east below, the east-west above). Thus, I think, the first of the three questions put forward has been answered in the affirmative: the trade-like winds are trades.

As to the second question, we may consider first the southern winter season. In it the gradient Australia-Java is reversed at the level of ± 5 kilometers. But does it change too in the other season at 3 kilometers? Apparently not, because, going upward, the easterly winds do not then change to westerly ones; they back only from ESE. to ENE., while the velocity does not vanish. Now, admitting the absence of friction in these layers,

[1] Cf. Mo. WEATHER REV., January, 1922, 50:26.
[1] Proceedings, April 16, 1918.
[2] *Tijdschrift v. h. K. Aardrijkskundig Gen.*, vol. 35, 1918, No. 1, and vol. 36, 1919, No. 4.
[3] Owing to a typographical error in the synoptical table the velocities at the levels 18, 19, and 20 kilometers for June have wrongly been given as 1 meter per second instead of 10 meters per second.

and consequently assuming the current to follow the course of the isobars, we come to the conclusion that this course remains mainly the same when going upward, or the Australian HIGH subsists in these higher layers, though perhaps shifting somewhat to the eastward.

Accepting this, we may ask: Might it be that the antitrade-like current flows around the Australian HIGH, bringing about thus the deflux towards the subtropics?

In that case the antitrade-like current should be a true antitrade, although of local character. But then we are obliged to admit that a flux toward the Equator will also occur at the opposite side of the oval system of the Australian HIGH; only the deflux should surpass it by the mass of air (or part of it) which ascends from the surface in the equatorial belt.

This influx, too, may give us an answer to our third question: What is the cause of the great east-west velocities of antitrade-like and upper trade-like winds? Exner[4] points to the fact that ascension of air at the Equator is able to increase its east-west velocity only by a fraction, and, therefore, tries to explain the great velocities of high equatorial east winds by shifting of air from higher latitudes towards the Equator with preservation of rotational moment. A meridional shift from latitude $\pm 15°$ causes velocities from 30–40 meters per second.

My result for the antitrade-like current over Java is the same as that obtained by Sir Napier Shaw when calculating isobars for the level at 8,000 meters.[5] He, too, finds long-stretched HIGHS, and he speaks of the flowing of air around these HIGHS, by which the east-west wind velocities of the Equator act on the opposite currents of the subtropics as by chain-drive pulling.

However, through lack of data Sir Napier Shaw had to calculate his isobars by means of one and the same set of vertical temperature gradients for the whole hemisphere, which, of course, makes the results somewhat doubtful for the equatorial belt, because there the critical pressure differences at the 8,000-meter level are small only.

For that reason I have sought for another independent way to solve the antitrade problem, and I think I have found it by mapping the average directions of cirrus drift as observed in the equatorial belt.

Cirrus floats there at levels of about 11 kilometers, and at that height over Java the antitrade-like winds blow from May until October, while during the rest of the year winds with trade-like character prevail.

The mean directions of cirrus drift which were at my disposal (mostly borrowed from H. Hildebrandsson[6]) I plotted separately for winter and summer, and although they are very sparse I made an endeavor to construct lines of flow. The result is incorporated in the accompanying maps. (Fig. 1.) They should be regarded as a first trial; e. g., no attention was given to the density of the lines of flow, only to their direction. For three stations (Hawaii, Ascension, and Congo) only annual means were given, and they have been used for both summer and winter.

Trying to design the lines of flow, it was apparent this could be done only by assuming oblong systems to exist at both sides of the equator, together with a zonal stream winding about the equator. Of these ovals those lying over central America, northern Africa, and southern Asia correspond fairly well with the isobaric HIGHS found by Sir Napier Shaw at the 8-kilometer level.

[4] *Dynamische Meteorologie*, 1917, p. 182.
[5] Rede Lecture, *Nature*, July 21, 1921, p. 653. Sir Napier Shaw most kindly provided me recently with a copy of the unpublished *isobaric charts* which he constructed for the Northern Hemisphere.
[6] Les Bases de la Météologie, II. Also Nova Acta R. Soc. Sc. Upsaliensis, ser. 4, vol. 5, No. 1.

Estimating roughly the latitudes of the centers of the current ovals, I find—

Oval over.	Latitude of center.		Seasonal shift.
	Winter.	Summer.	
Central America	20 N.	28 N.	8
Northern Africa	8 N.	25 N.	17
Southern Africa	(?)	18 S.	......
Arabian Sea	......	0	......
Bengalese Sea	15 N.	......	......
East Asia	17 N.	30 N.	13
Australia	13 S.	10 S.	3
Mean	......	......	10

The mean latitude of the northern ovals is about 20°, that of the southern about 15°. At the surface of the earth pressure is highest in latitudes 35° N. and 30° S.; accordingly, when identifying the current ovals with pressure HIGHS, the latter are 15° nearer to the Equator at the 11-kilometer level than at sea level. This shifting is in agreement with the considerations of Teisserenc de

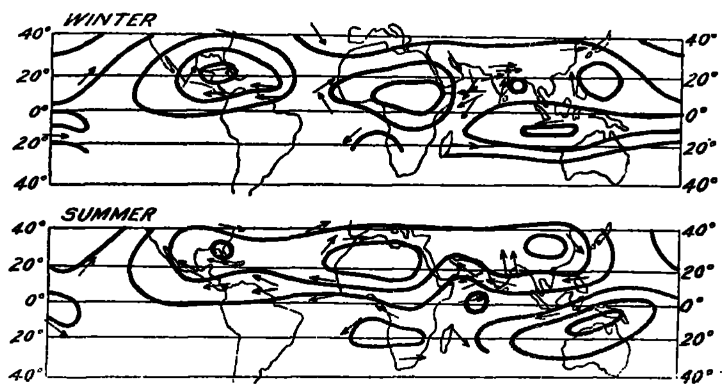

FIG. 1.—Lines of flow of cirrus drift.

Bort and Exner (loc. cit., p. 177), according to which the high-pressure belts with increasing height move toward the equator.

The mean amount of seasonal shifting found above, i. e., 10°, fairly agrees with the correspondence shifting of these high-pressure belts at the surface:

Northern belt:		Southern belt:	
January	32° N.	January	37° S.
July	39° N.	July	28° S.
Shift	7°	Shift	9°

Resuming, it seems probable that in high levels above the Equator and winding about it flows a zonal east-west current of stationary character, which is fed by ascending surface air and locally by air streaming in from higher latitudes, which, moreover, maintains its east-west motion. Also, that from it flows off in other places air to the subtropical belts; these currents of deflux bend from an east-west to a west-east direction.

This communication may prove anew that the knowledge of the direction of the cirrus drift in the equatorial belt is important for the investigation of atmospheric circulation between the Tropics, but that the observations at our disposal are few and rather insufficient. For that reason I appeal to those who are in the position to make these observations to supply this need.

To observe in what direction cirrus floats is easy and requires simple means only; moreover, observations are not confined to fixed hours or days. Thus they are particularly adapted to be made by amateurs living in the tropical regions.